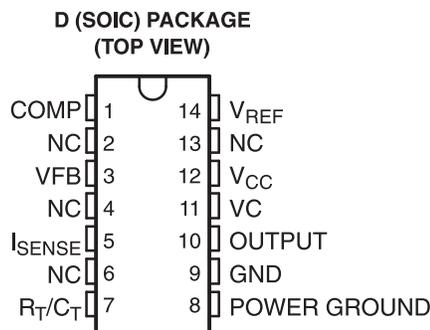


## HIGH-PERFORMANCE CURRENT-MODE PWM CONTROLLER

 Check for Samples: [TL2843B-Q1](#)

### FEATURES

- Qualified for Automotive Applications
- Low Start-Up Current (<0.5 mA)
- Trimmed Oscillator Discharge Current
- Current Mode Operation to 500 kHz
- Automatic Feed-Forward Compensation
- Latching PWM for Cycle-by-Cycle Current Limiting
- Internally Trimmed Reference With Undervoltage Lockout
- High-Current Totem-Pole Output Undervoltage Lockout With Hysteresis
- Double-Pulse Suppression



NC – No internal connection

### DESCRIPTION

The TL284xB series of control integrated circuits provide the features that are necessary to implement off-line or dc-to-dc fixed-frequency current-mode control schemes, with a minimum number of external components. Internally implemented circuits include an undervoltage lockout (UVLO) and a precision reference that is trimmed for accuracy at the error amplifier input. Other internal circuits include logic to ensure latched operation, a pulse-width modulation (PWM) comparator that also provides current-limit control, and a totem-pole output stage designed to source or sink high-peak current. The output stage, suitable for driving N-channel MOSFETs, is low when it is in the off state.

The TL284xB series are pin compatible with the standard TL284x with the following improvements. The start-up current is specified to be 0.5 mA (max), while the oscillator discharge current is trimmed to 8.3 mA (typ). In addition, during undervoltage lockout conditions, the output has a maximum saturation voltage of 1.2 V while sinking 10 mA ( $V_{CC} = 5$  V).

Major differences between members of these series are the UVLO thresholds and maximum duty-cycle ranges. Typical UVLO thresholds of 16 V (on) and 10 V (off) on the TL2842B and TL2844B devices make them ideally suited to off-line applications. The corresponding typical thresholds for the TL2843B and TL2845B devices are 8.4 V (on) and 7.6 V (off). The TL2842B and TL2843B devices can operate to duty cycles approaching 100%. A duty-cycle range of 0% to 50% is obtained by the TL2844B and TL2845B by the addition of an internal toggle flip-flop, which blanks the output off every other clock cycle. The TL284xB-series devices are characterized for operation from  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ .

**Table 1. ORDERING INFORMATION<sup>(1)</sup>**

$T_A$	PACKAGE <sup>(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 125°C	SOIC – D	Reel of 2500	TL2842BQDRQ1	Product Preview
			TL2843BQDRQ1	TL2843BQ
			TL2844BQDRQ1	Product Preview
			TL2845BQDRQ1	Product Preview

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at [www.ti.com](http://www.ti.com).

(2) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

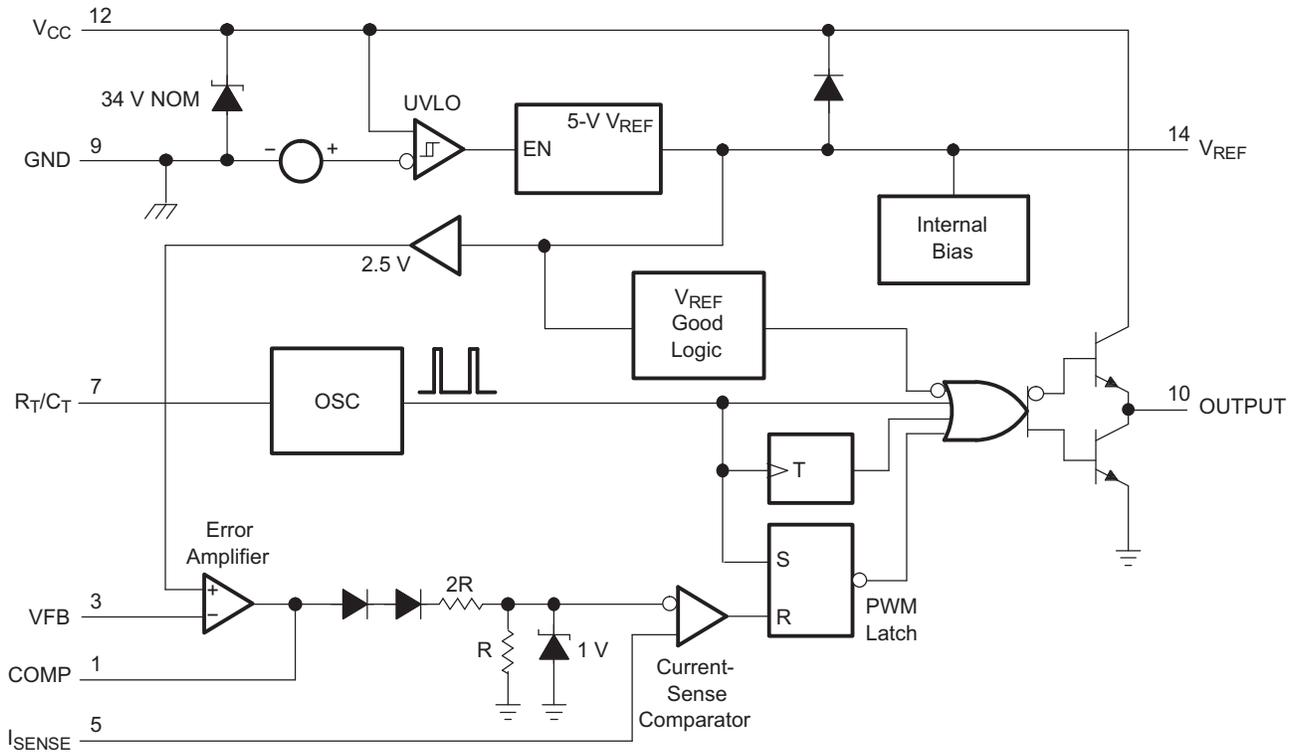


Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

**FUNCTIONAL BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS<sup>(1) (2)</sup>**

over operating free-air temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V <sub>CC</sub>	Supply voltage	Low impedance source		30
		I <sub>CC</sub> < 30 mA		Self limiting
V <sub>I</sub>	Analog input voltage range	VFB and I <sub>SENSE</sub>	-0.3	6.3
I <sub>CC</sub>	Supply current		30	mA
I <sub>O</sub>	Output current		±1	A
I <sub>O(sink)</sub>	Error amplifier output sink current		10	mA
θ <sub>JA</sub>	Package thermal impedance <sup>(3) (4)</sup>	D package	97	°C/W
	Output energy	Capacitive load	5	μJ
T <sub>J</sub>	Virtual junction temperature		150	°C
T <sub>stg</sub>	Storage temperature range		-65	150

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) All voltages are with respect to the device GND terminal.
- (3) Maximum power dissipation is a function of T<sub>J(max)</sub>, θ<sub>JA</sub>, and T<sub>A</sub>. The maximum allowable power dissipation at any allowable ambient temperature is P<sub>D</sub> = (T<sub>J(max)</sub> - T<sub>A</sub>)/θ<sub>JA</sub>. Operating at the absolute maximum T<sub>J</sub> of 150°C can impact reliability.
- (4) The package thermal impedance is calculated in accordance with JESD 51-7.

**RECOMMENDED OPERATING CONDITIONS**

		MIN	NOM	MAX	UNIT
V <sub>CC</sub>	Supply voltage	V <sub>CC</sub>		30	V
		VC <sup>(1)</sup>		30	
V <sub>I</sub>	Input voltage	R <sub>T</sub> /C <sub>T</sub>		0	V
		VFB and I <sub>SENSE</sub>		0	
V <sub>O</sub>	Output voltage	OUTPUT		0	V
		POWER GROUND <sup>(1)</sup>		-0.1	
I <sub>CC</sub>	Supply current, externally limited			25	mA
I <sub>O</sub>	Average output current			200	mA
I <sub>O(ref)</sub>	Reference output current			-20	mA
f <sub>osc</sub>	Oscillator frequency		100	500	kHz
T <sub>A</sub>	Operating free-air temperature	-40		125	°C

- (1) The recommended voltages for VC and POWER GROUND apply only to the 14-pin D package.

## REFERENCE SECTION ELECTRICAL CHARACTERISTICS

$V_{CC} = 15\text{ V}^{(1)}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 3.3\text{ nF}$ , over recommended operating free-air temperature range (unless otherwise specified)

PARAMETER	TEST CONDITIONS	TL284xB			UNIT
		MIN	TYP <sup>(2)</sup>	MAX	
Output voltage	$I_O = 1\text{ mA}$ , $T_J = 25^\circ\text{C}$	4.95	5	5.05	V
Line regulation	$V_{CC} = 12\text{ V to }25\text{ V}$		6	20	mV
Load regulation	$I_O = 1\text{ mA to }20\text{ mA}$		6	25	mV
Average temperature coefficient of output voltage			0.2	0.4	mV/°C
Output voltage, worst-case variation	$V_{CC} = 12\text{ V to }25\text{ V}$ , $I_O = 1\text{ mA to }20\text{ mA}$	4.9		5.1	V
Output noise voltage	$f = 10\text{ Hz to }10\text{ kHz}$ , $T_J = 25^\circ\text{C}$		50		$\mu\text{V}$
Output-voltage long-term drift	After 1000 h at $T_J = 25^\circ\text{C}$		5	25	mV
Short-circuit output current		-30	-100	-180	mA

(1) Adjust  $V_{CC}$  above the start threshold before setting it to 15 V.

(2) All typical values are at  $T_J = 25^\circ\text{C}$ .

## OSCILLATOR SECTION<sup>(1)</sup> ELECTRICAL CHARACTERISTICS

$V_{CC} = 15\text{ V}^{(2)}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 3.3\text{ nF}$ , over recommended operating free-air temperature range (unless otherwise specified)

PARAMETER	TEST CONDITIONS	TL284xB			UNIT
		MIN	TYP <sup>(3)</sup>	MAX	
Initial accuracy	$T_J = 25^\circ\text{C}$	49	52	55	kHz
	$T_A = T_{\text{low}} \text{ to } T_{\text{high}}$	48		56	
	$T_J = 25^\circ\text{C}$ , $R_T = 6.2\text{ k}\Omega$ , $C_T = 1\text{ nF}$	225	250	275	
Voltage stability	$V_{CC} = 12\text{ V to }25\text{ V}$		0.2	1	%
Temperature stability			5		%
Amplitude	Peak to peak		1.7		V
Discharge current <sup>(4)</sup>	$T_J = 25^\circ\text{C}$ , $R_T/C_T = 2\text{ V}$	7.8	8.3	8.8	mA
	$R_T/C_T = 2\text{ V}$	7.5		8.8	

(1) Output frequency equals oscillator frequency for the TL2842B and TL2843B. Output frequency is one-half the oscillator frequency for the TL2844B and TL2845B.

(2) Adjust  $V_{CC}$  above the start threshold before setting it to 15 V.

(3) All typical values are at  $T_J = 25^\circ\text{C}$ .

(4) Specified by design. Not production tested.

## ERROR-AMPLIFIER SECTION ELECTRICAL CHARACTERISTICS

$V_{CC} = 15\text{ V}^{(1)}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 3.3\text{ nF}$ , over recommended operating free-air temperature range (unless otherwise specified)

PARAMETER	TEST CONDITIONS	TL284xB			UNIT
		MIN	TYP <sup>(2)</sup>	MAX	
Feedback input voltage	COMP = 2.5 V	2.45	2.5	2.55	V
Input bias current			-0.3	-1	$\mu\text{A}$
Open-loop voltage amplification	$V_O = 2\text{ V to }4\text{ V}$	65	90		dB
Gain-bandwidth product		0.7	1		MHz
Supply-voltage rejection ratio	$V_{CC} = 12\text{ V to }25\text{ V}$	60	70		dB
Output sink current	VFB = 2.7 V, COMP = 1.1 V	2	6		mA
Output source current	VFB = 2.3 V, COMP = 5 V	-0.5	-0.8		mA
High-level output voltage	VFB = 2.3 V, $R_L = 15\text{ k}\Omega$ to GND	5	6		V
Low-level output voltage	VFB = 2.7 V, $R_L = 15\text{ k}\Omega$ to GND		0.7	1.1	V

(1) Adjust  $V_{CC}$  above the start threshold before setting it to 15 V.

(2) All typical values are at  $T_J = 25^\circ\text{C}$ .

## CURRENT-SENSE SECTION ELECTRICAL CHARACTERISTICS

$V_{CC} = 15\text{ V}^{(1)}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 3.3\text{ nF}$ , over recommended operating free-air temperature range (unless otherwise specified)

PARAMETER	TEST CONDITIONS	TL284xB			UNIT
		MIN	TYP <sup>(2)</sup>	MAX	
Voltage amplification <sup>(3) (4)</sup>		2.85	3	3.15	V/V
Current-sense comparator threshold <sup>(3)</sup>	COMP = 5 V	0.9	1	1.1	V
Supply-voltage rejection ratio <sup>(3)</sup>	$V_{CC} = 12\text{ V to }25\text{ V}$		70		dB
Input bias current			-2	-10	$\mu\text{A}$
Delay time to output <sup>(5)</sup>	VFB = 0 V to 2 V		150	300	ns

(1) Adjust  $V_{CC}$  above the start threshold before setting it to 15 V.

(2) All typical values are at  $T_J = 25^\circ\text{C}$ .

(3) Measured at the trip point of the latch, with VFB at 0 V.

(4) Measured between  $I_{SENSE}$  and COMP, with the input changing from 0 V to 0.8 V.

(5) Specified by design. Not production tested.

### Output Section Electrical Characteristics

$V_{CC} = 15\text{ V}^{(1)}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 3.3\text{ nF}$ , over recommended operating free-air temperature range (unless otherwise specified)

PARAMETER	TEST CONDITIONS	TL284xB			UNIT
		MIN	TYP <sup>(2)</sup>	MAX	
High-level output voltage	$I_{OH} = -20\text{ mA}$	13	13.5		V
	$I_{OH} = -200\text{ mA}$	12	13.5		
Low-level output voltage	$I_{OL} = 20\text{ mA}$		0.1	0.4	V
	$I_{OL} = 200\text{ mA}$		1.5	2.2	
Rise time <sup>(3)</sup>	$C_L = 1\text{ nF}$ , $T_J = 25^\circ\text{C}$		50	150	ns
Fall time <sup>(3)</sup>	$C_L = 1\text{ nF}$ , $T_J = 25^\circ\text{C}$		50	150	ns
UVLO saturation <sup>(3)</sup>	$V_{CC} = 5\text{ V}$ , $I_{OL} = 1\text{ mA}$		0.7	1.2	V

- (1) Adjust  $V_{CC}$  above the start threshold before setting it to 15 V.
- (2) All typical values are at  $T_J = 25^\circ\text{C}$ .
- (3) Specified by design. Not production tested.

### UNDERVOLTAGE-LOCKOUT SECTION ELECTRICAL CHARACTERISTICS

$V_{CC} = 15\text{ V}^{(1)}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 3.3\text{ nF}$ , over recommended operating free-air temperature range (unless otherwise specified)

PARAMETER	TEST CONDITIONS	TL284xB			UNIT
		MIN	TYP <sup>(2)</sup>	MAX	
Start threshold voltage		7.8	8.4	9	V
Minimum operating voltage after start-up		7	7.6	8.2	V

- (1) Adjust  $V_{CC}$  above the start threshold before setting it to 15 V.
- (2) All typical values are at  $T_J = 25^\circ\text{C}$ .

### PULSE-WIDTH MODULATOR SECTION ELECTRICAL CHARACTERISTICS

$V_{CC} = 15\text{ V}^{(1)}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 3.3\text{ nF}$ , over recommended operating free-air temperature range (unless otherwise specified)

PARAMETER	TEST CONDITIONS	TL284xB			UNIT
		MIN	TYP <sup>(2)</sup>	MAX	
Maximum duty cycle <sup>(3)</sup>		94	96	100	%
Minimum duty cycle				0	%

- (1) Adjust  $V_{CC}$  above the start threshold before setting it to 15 V.
- (2) All typical values are at  $T_J = 25^\circ\text{C}$ .
- (3) Specified by design. Not production tested.

### SUPPLY VOLTAGE ELECTRICAL CHARACTERISTICS

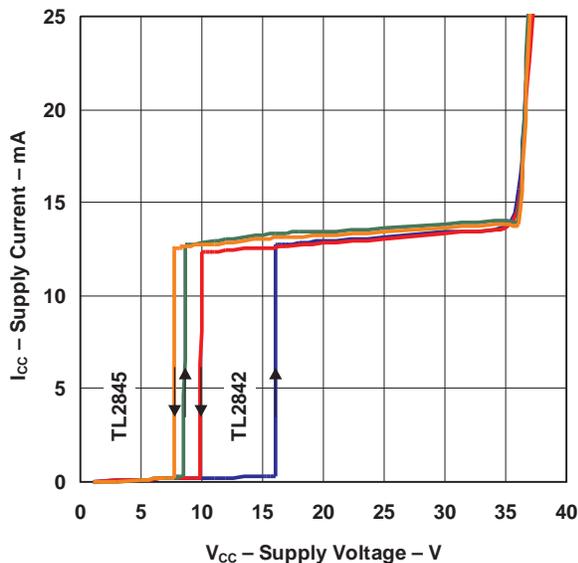
$V_{CC} = 15\text{ V}^{(1)}$ ,  $R_T = 10\text{ k}\Omega$ ,  $C_T = 3.3\text{ nF}$ , over recommended operating free-air temperature range (unless otherwise specified)

PARAMETER	TEST CONDITIONS	TL284xB			UNIT
		MIN	TYP <sup>(2)</sup>	MAX	
Start-up current			0.3	0.5	mA
Operating supply current	VFB and $I_{SENSE}$ at 0 V		11	17	mA
Limiting voltage	$I_{CC} = 25\text{ mA}$	30	34		V

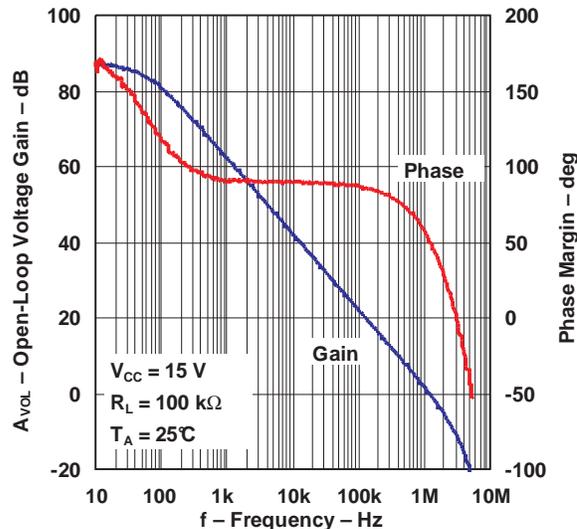
- (1) Adjust  $V_{CC}$  above the start threshold before setting it to 15 V.
- (2) All typical values are at  $T_J = 25^\circ\text{C}$ .

TYPICAL CHARACTERISTICS

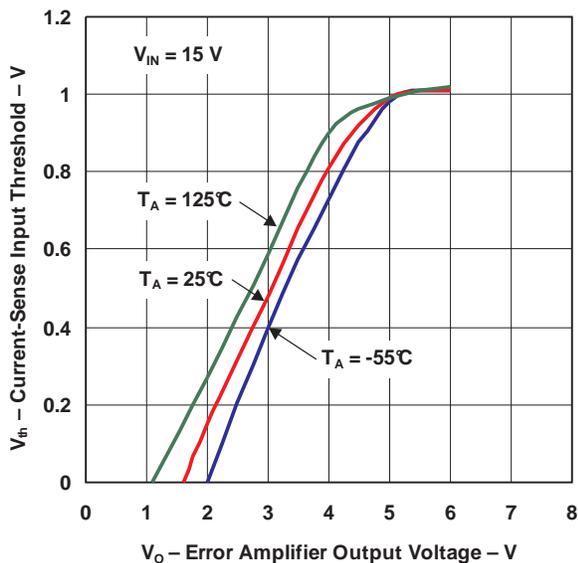
SUPPLY CURRENT  
vs  
SUPPLY VOLTAGE



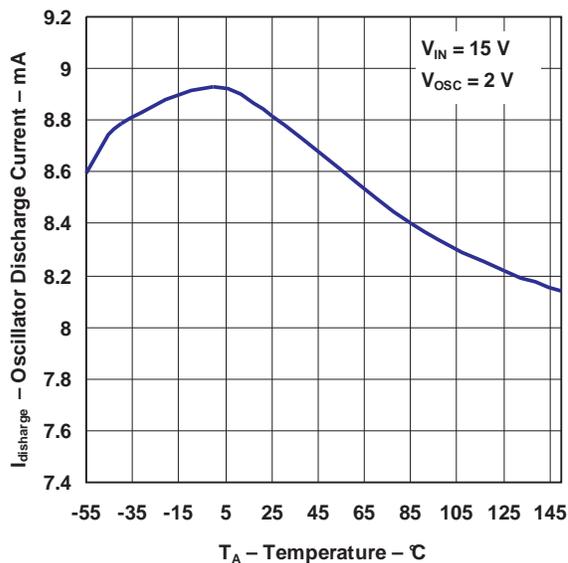
ERROR AMPLIFIER OPEN-LOOP  
GAIN AND PHASE  
vs  
FREQUENCY



CURRENT-SENSE INPUT THRESHOLD  
vs  
ERROR AMPLIFIER OUTPUT VOLTAGE

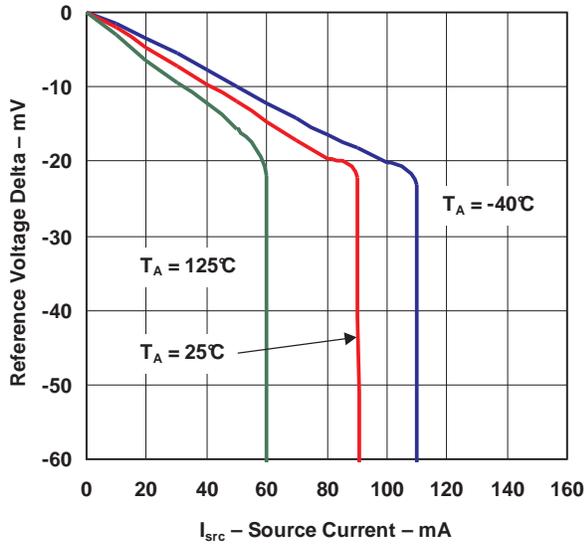


OSCILLATOR DISCHARGE CURRENT  
vs  
TEMPERATURE

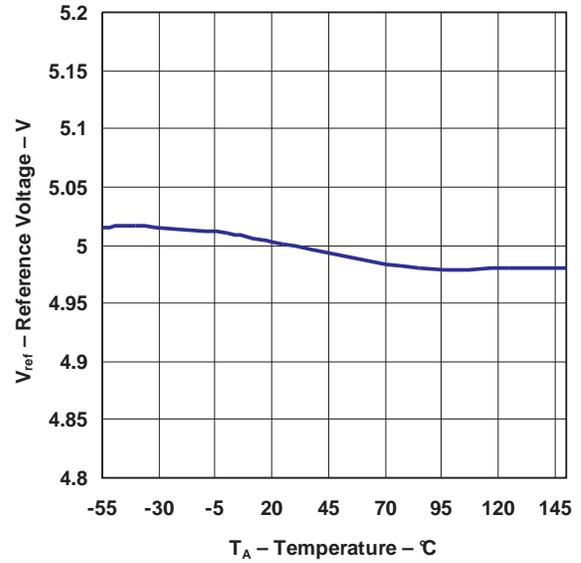


**TYPICAL CHARACTERISTICS (continued)**

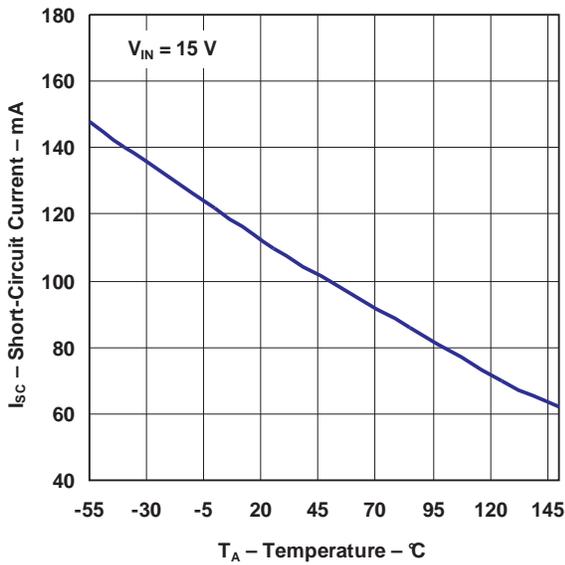
**REFERENCE VOLTAGE  
vs  
SOURCE CURRENT**



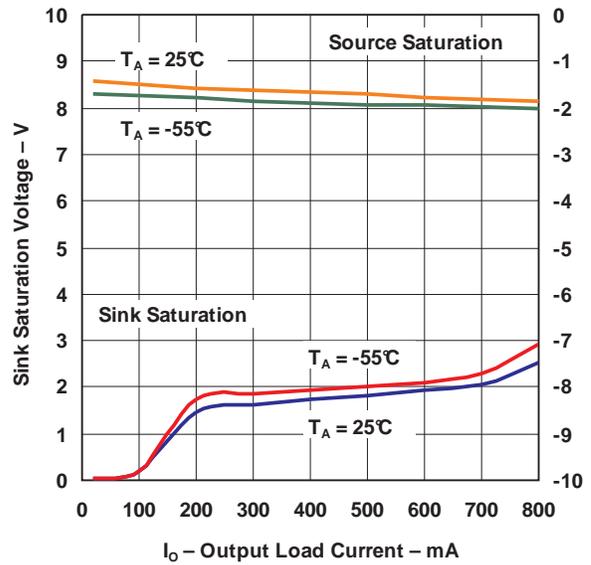
**REFERENCE VOLTAGE  
vs  
TEMPERATURE**



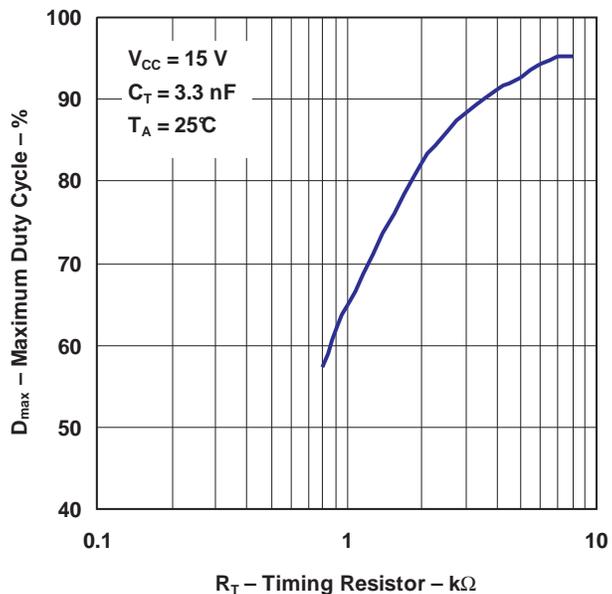
**REFERENCE SHORT-CIRCUIT CURRENT  
vs  
TEMPERATURE**



**OUTPUT SATURATION VOLTAGE  
vs  
LOAD CURRENT**

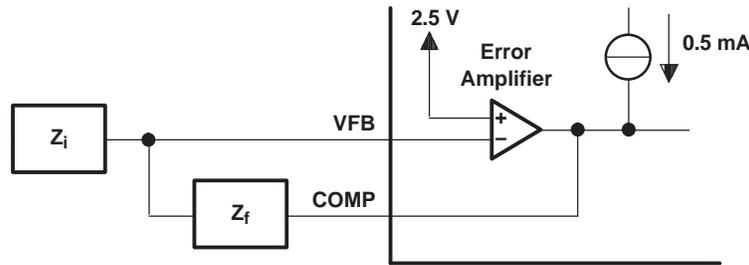


**TYPICAL CHARACTERISTICS (continued)**  
**MAXIMUM OUTPUT DUTY CYCLE**  
**vs**  
**TIMING RESISTOR**



**APPLICATION INFORMATION**

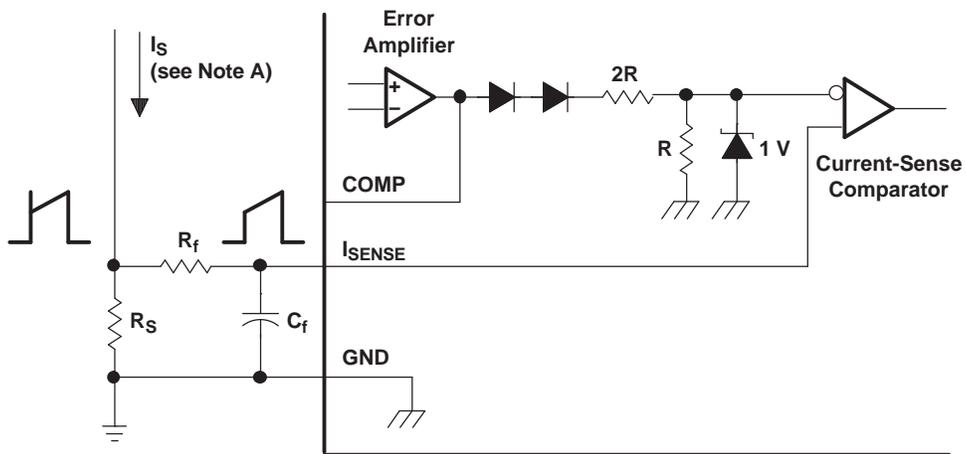
The error-amplifier configuration circuit is shown in Figure 1.



- A. Error amplifier can source or sink up to 0.5 mA.

**Figure 1. Error-Amplifier Configuration**

The current-sense circuit is shown in Figure 2.



- A. Peak current ( $I_S$ ) is determined by the formula:  $I_{S(max)} = 1 V/R_S$
- B. A small RC filter formed by resistor  $R_f$  and capacitor  $C_f$  may be required to suppress switch transients.

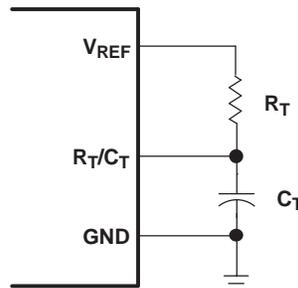
**Figure 2. Current-Sense Circuit**

The oscillator frequency is set using the circuit shown in Figure 3. The frequency is calculated as:

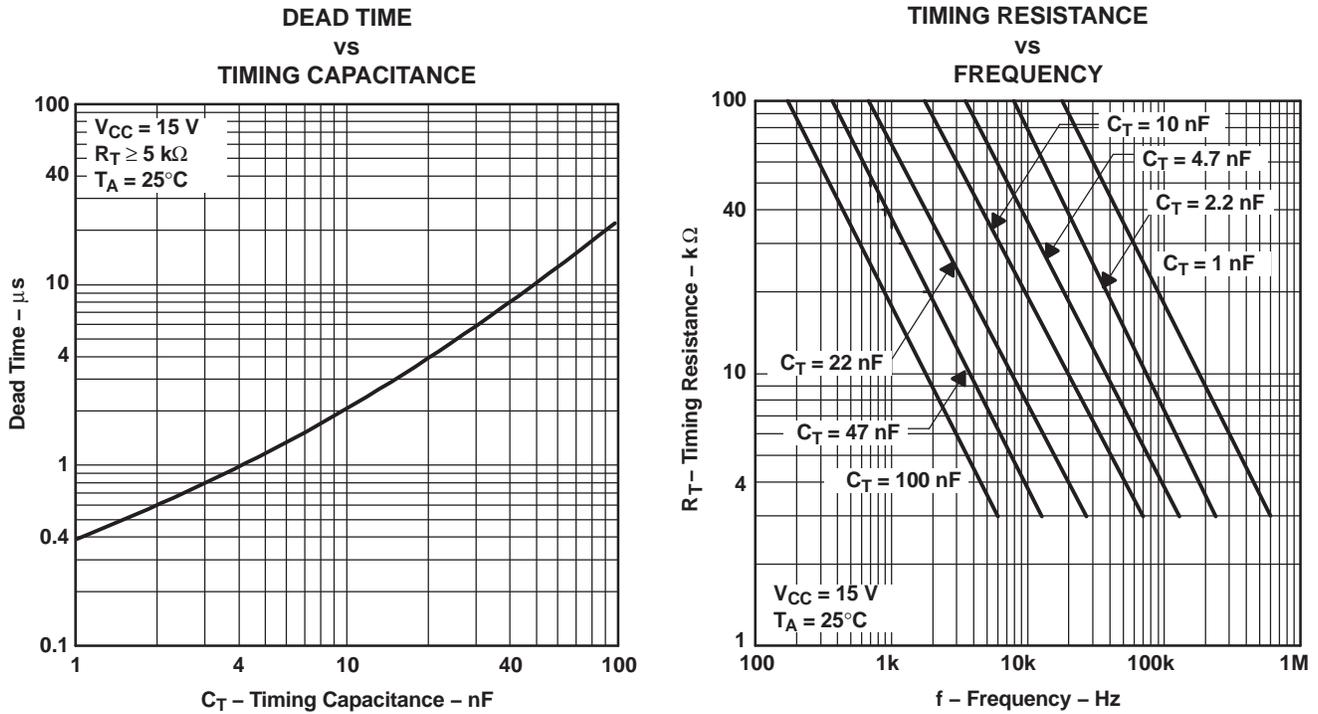
$$f = 1 / R_T C_T$$

For  $R_T > 5 \text{ k}\Omega$ :

$$f \approx 1.72 / R_T C_T$$



**Figure 3. Oscillator Section**



### Open-Loop Laboratory Test Fixture

In the open-loop laboratory test fixture (see Figure 4), high peak currents associated with loads necessitate careful grounding techniques. Timing and bypass capacitors should be connected close to the GND terminal in a single-point ground. The transistor and 5-k $\Omega$  potentiometer sample the oscillator waveform and apply an adjustable ramp to the  $I_{\text{SENSE}}$  terminal.

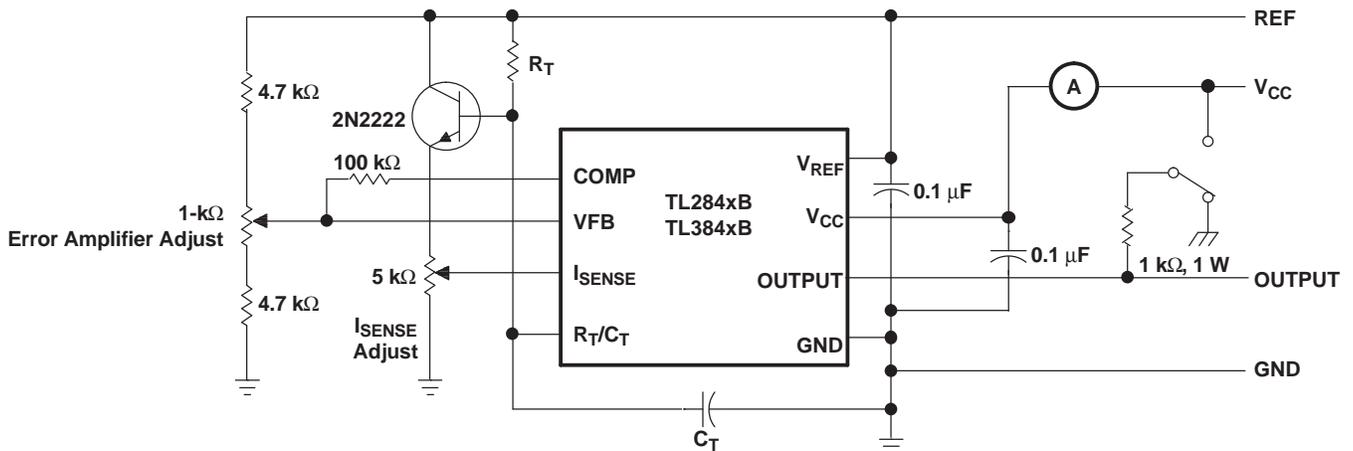


Figure 4. Open-Loop Laboratory Test Fixture

### Shutdown Technique

The PWM controller (see [Figure 5](#)) can be shut down by two methods: either raise the voltage at  $I_{SENSE}$  above 1 V or pull the COMP terminal below a voltage two diode drops above ground. Either method causes the output of the PWM comparator to be high (see the *Functional Block Diagram*). The PWM latch is reset dominant so that the output remains low until the next clock cycle after the shutdown condition at the COMP or  $I_{SENSE}$  terminal is removed. In one example, an externally latched shutdown can be accomplished by adding an SCR that resets by cycling  $V_{CC}$  below the lower UVLO threshold. At this point, the reference turns off, allowing the SCR to reset.

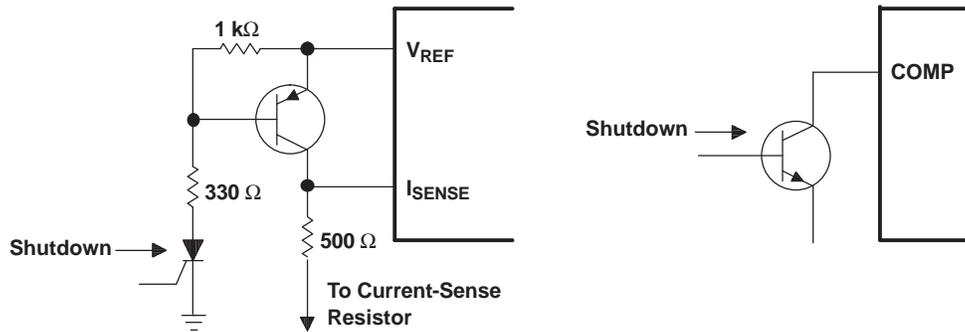


Figure 5. Shutdown Techniques

A fraction of the oscillator ramp can be summed resistively with the current-sense signal to provide slope compensation for converters requiring duty cycles over 50% (see [Figure 6](#)). Note that capacitor C forms a filter with R2 to suppress the leading-edge switch spikes.

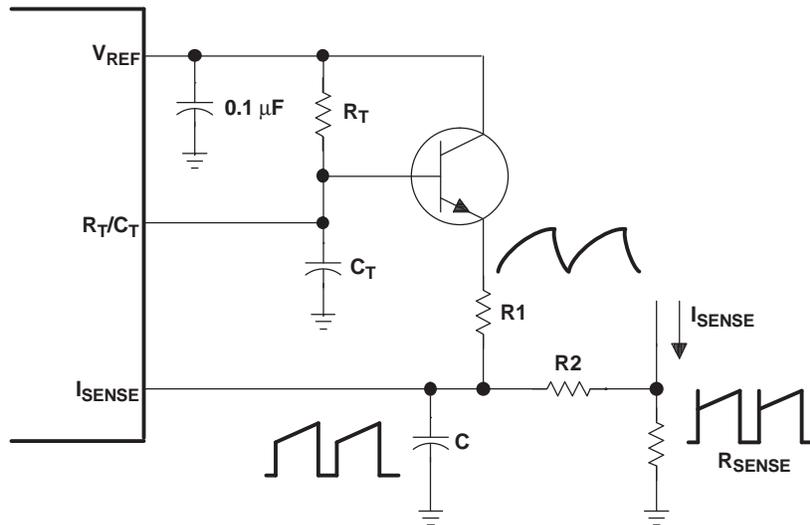


Figure 6. Slope Compensation

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**REVISION HISTORY**

<b>Changes from Original (July 2012) to Revision A</b>	<b>Page</b>
• Changed the pinout from an 8-pin to 14-pin D package .....	1
• Changed the Functional Block diagram pin numbers for the 14-pin D package .....	2

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**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/ Ball Finish	MSL Peak Temp <sup>(3)</sup>	Samples (Requires Login)
TL2843BQDRQ1	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TL2843B-Q1 :**

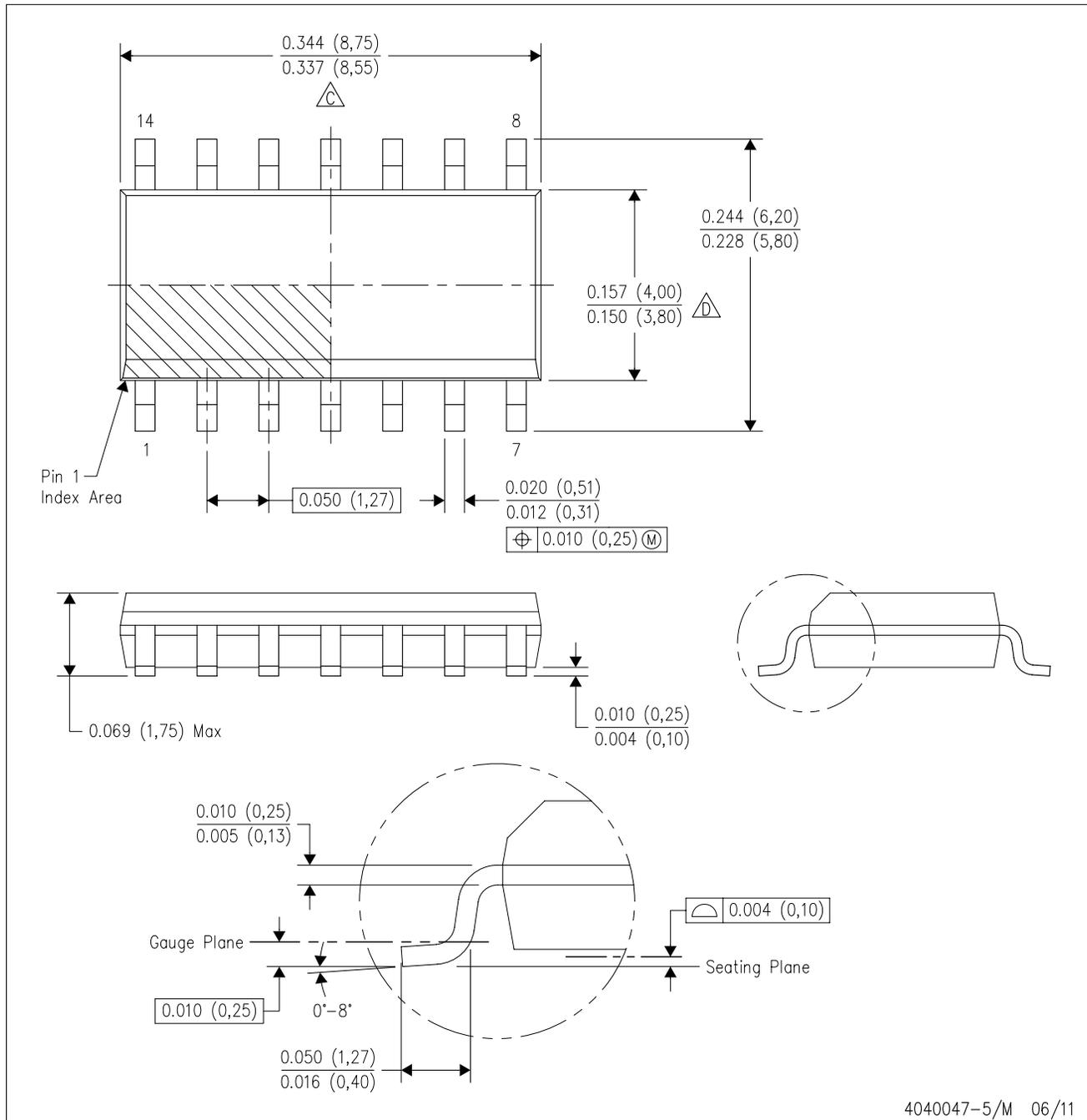
- Catalog: [TL2843B](#)

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

D (R-PDSO-G14)

PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  -  Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.006 (0,15) each side.
  -  Body width does not include interlead flash. Interlead flash shall not exceed 0.017 (0,43) each side.
  - E. Reference JEDEC MS-012 variation AB.

## IMPORTANT NOTICE

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